

**HEAD SUSPENSION WITH VIBRATION DAMPING  
FOR A  
DATA STORAGE DEVICE**

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**Field of the Invention**

The invention relates to the field of data storage devices. More particularly, but not by way of limitation, this invention relates to a combination and method for  
5   dissipating excitation experienced by components in a data storage device.

**Background**

One key component of any computer system is a device to store data. One common type of data storage device is a disc drive. The most basic parts of a disc  
10   drive are an information storage disc that is rotated, an actuator that moves a read/write head (head) to various locations over the substantially concentric data tracks of a disc, and electrical circuitry used for encoding data so that the data can be successfully retrieved and written to the disc surface. A microprocessor controls most of the operations of the disc drive including passing requested data  
15   read by the transducer to the computer system and receiving data from the computer system for storage on the disc.

A problem associated with disc drives is vibrations at certain frequencies, which causes the head to move off a designated data track. In other words, if there is even a slight vibration, the head may move away from the center of the  
20   designated data track, causing data to be misread or causing a failure to properly write data. One source of vibration results from a seek operation that excites head suspensions, which in turn causes the head to vibrate. The vibration causes run-out, i.e., an off-track motion, and off-track motion becomes more acute as the density of the data tracks increase. As such, challenges remain and a need persists  
25   for improvements in methods and apparatus to reduce vibrations in head suspensions for data storage devices.

## Summary of the Invention

In accordance with preferred embodiments, a method, apparatus and combination are provided for dissipation of vibrations experienced by a read/write head of a data storage device. The combination includes a rotating disc in a data exchange relationship with a read/write head, which is supported by a head suspension formed by steps for forming the head suspension.

In one aspect, the method includes forming a mounting region of the head suspension adjacent a bend region, forming a load beam region adjacent the bend region, and removing material from the bend region to form a strut and a damping material support structure. The method preferably continues with the steps of severing the strut from the damping material support structure to provide an isolation aperture and a base portion of the damping material support structure. A damping material is preferably affixed to the strut and the damping material support structure, wherein the damping material partially obstructs the isolation aperture.

In another aspect, an apparatus comprising a head suspension that preferably includes a mounting region that has a mounting aperture with an attachment member secured adjacent the mounting aperture, and a bend region with an aperture bounded by a number of struts. The struts regulate an amount of spring force imparted to a read/write head. The apparatus further preferably includes a load beam region with a damping material support structure adjacent a bend member, the damping material support structure is offset from the struts and extends into the aperture.

Preferably, the load beam region includes a proximal end adjacent the bend region and a distal end with a rigid portion. The distal end extends from the proximal end and a flexure is preferably affixed to the rigid portion to support the read/write head. Preferably, the damping material support structure extends into the aperture from the proximal end of the load beam to allow an adhesion of the damping material to the struts while minimizing potential exposure of the read/write head and the disc to an adhesive medium of the damping material.

These and various other features and advantages that characterize the claimed invention will be apparent upon reading the following detailed description and upon review of the associated drawings.

### **Brief Description of the Drawings**

**FIG. 1** is a partial cutaway top plan view of a data storage device (DSD) that incorporates a head suspension of the present invention.

5       **FIG. 2** is a top plan view of the head suspension of **FIG. 1**.

**FIG. 3** is a top perspective view of the head suspension of **FIG. 2**.

**FIG. 4** is a flow chart of a method of forming the head suspension of **FIG. 2**.

### **Detailed Description**

10       Referring now to the drawings, **FIG. 1** provides a top plan view of a data storage device (DSD) **100**. The DSD **100** includes a base deck **102** cooperating with a top cover **104** (shown in partial cutaway) to form a sealed housing for a mechanical portion of the DSD **100**, referred to as a head-disc assembly **106**.

15       A spindle motor assembly **108** rotates a number of data storage discs **110** with a magnetic recording surface **111** at a substantially constant operational speed. An actuator assembly (actuator) **112** supports and rotates a number of read/write heads (heads) **114** adjacent the magnetic recording surfaces **111** when current is applied to a coil **116** of a voice coil motor (VCM) **118**. A head  
20       suspension **120** provides a predetermined spring force on the head **114** to maintain a proper data exchange relationship between the head **114** and the disc **110** during operation of the DSD **100**. Additionally, the head suspension **120** serves to connect the head **114** with an actuator arm **122** of the actuator **112**.

25       During operation of the DSD **100**, the actuator **112** moves the heads **114** into a data exchange relationship with the disc **110**, i.e., the actuator **112** moves the heads to data tracks **124** on the surfaces **111** to write data to and read data from the discs **110**. When the DSD **100** is deactivated, the actuator **112** positions the heads **114** adjacent a home position **126** and the actuator **112** is confined by latching a toggle latch **128**.

30       Command, control and interface electronics for the DSD **100** are provided on a printed circuit board assembly **130** mounted to the head-disc assembly **106**. During data transfer operations, a preamplifier/driver (preamp) **132** attached to a

flex circuit 134 conditions read/write signals conducted by the flex circuit 134 between the printed circuit board assembly 130 and the heads 114.

**FIG. 2** shows a preferred embodiment of the head suspension 120, which includes a damping material support structure 136. The damping material support structure 136 allows a large damping material 138 to be applied in a high strain area 140, without undue exposure of an adhesive (not shown) of the damping material 138 or damage to a bend region 142 of the head suspension 120. The large damping material 138, enabled by the damping material support structure 136, helps to dissipate undesirable resonant vibrations in the head suspension 120.

In a preferred embodiment, the bend region 142 has a pair of bend members (also referred to herein as struts) 144 used to achieve a desired spring rate and load for the head 114. As a result, the strain energy for most resonant modes is highest in the high strain area 140 of the struts 144. Dampers are most effective in areas of high strain and the damping material support structure 136 promotes a cost effective application of damping to the struts 144. Because of the preferred embodiment configuration of the damping material support structure 136, ease in manufacturing of the damping material 136 results, due to its relatively large surface area. The relatively large surface area of the damping material 136 further provides the benefit of enhancing an accurate placement and application of the damping material 136 to the bend region 142 during the assembly process of the DSD 100 (of FIG.1).

An adhesive medium is preferably used to affix the damping material 138 to the struts 144 and to the damping material support structure 136. Excessive adhesive exposure may cause difficulties with handling the actuator 112 (of FIG. 1), and may further outgas particles into the head-disc assembly 106 (of FIG. 1), which can damage the disc 110 (of FIG. 1) or the head 114. The damping material support structure 136 minimizes adhesive exposure, without affecting performance of the struts 144. Preferably, adhesive exposure is minimized because the damping material support structure 136 supports the large damping material 138 and substantially covers the exposed adhesive area of the large damping material 138.

**FIG. 2** also shows a preferred isolation aperture 146, i.e., a thin space between the damping material support structure 136 and the struts 144 to maintain

suspension performance, but still provide access to the high strain area **140** on the struts **144** for application of the damping material **138**.

**FIG. 3** shows a mounting region **148** adjacent the bend region **142**. **FIG. 3** also shows a load beam region **150** with a proximal end **152** adjacent the bend region **142**. The load beam region **150** preferably includes a rigid portion **154** on a distal end **156** and a preferential stiffening rail **158** (two shown) commencing at the proximal end **152** and extending to the distal end **156**. The rigid portion **154** supports a flexure **160** upon which the head **114** (of **FIG. 1**) is preferably mounted. The stiffening rail **158** facilitates conveyance to the head **114** of a load developed by the spring rate of the strut **144**.

**FIG. 3** also shows a base portion **162** of the damping material support structure **136** preferentially adjacent the proximal end **152** of the load beam region **150**. The damping material support structure **136** preferably extends from the base portion **162** into an aperture **164**. During formation of the aperture **164**, a mounting aperture **166** is preferentially formed in the mounting region **148**, and an attachment member **168** is preferably affixed adjacent the mounting aperture **166**. The attachment member **168** facilitates mounting of the head suspension **120** to the actuator arm **122** of the actuator **112** (of **FIG. 1**).

Preferably, the amount of material removed during formation of the aperture **164** substantially determines the dimensions of the strut **144**. The dimensions of the strut **144** determines the amount of spring force and load applied to the head **114** (of **FIG. 1**) to assure the proper fly height of the head **114** during operations of the DSD **100** (of **FIG. 1**). **FIG. 3** further shows, an optional mass adjustment area **170** that may be etched onto the load beam region **150** to decrease the overall mass of the load beam region **150**.

**FIG. 4** shows a head suspension formation process **200** beginning at start step **202** and continuing at process step **204**. Preferably, at process step **204**, a mounting region (such as **148**), a bend region (such as **142**) and a load beam region (such as **150**) are formed. At process step **206**, material is removed to preferentially form a strut (such as **144**), a damping material support structure (such as **136**) and an aperture (such as **164**). The amount of material removed during formation of the aperture substantially defines the dimensions of the strut **144**, which determines the amount of spring force and load applied to a head (such

as **114**) of a DSD (such as **100**).

At process step **208**, a mounting aperture (such as **166**) and an isolation aperture (such as **146**) are provided by removing material from the mounting region (for the mounting aperture), and from the bend region (for the isolation aperture). The isolation aperture preferably provides a separation between the damping material support structure and the strut to assure non-interference with the operation of the strut by the damping material support structure. An attachment member (such as **168**) preferably encloses the mounting aperture and provides a means for mounting the head suspension to an actuator arm (such as **122**) of an actuator (such as **112**) of the DSD.

At process step **210**, a stiffening rail (such as **158**) and a rigid portion (such as **154**) are preferably formed in the load beam region. The stiffening rail transfers the load developed by the spring force from the strut to the head, and the rigid region supports a flexure (such as **160**) used to attach the head. At process step **212**, an optional mass adjustment area (such as **170**) is etched into the load beam region to reduce the overall mass of the load beam region. At process step **214**, the attachment member is joined to the mounting region and the flexure is joined to the rigid portion of the load beam region.

At process step **216**, the damping material is attached to the strut and the damping material support structure. Preferably, the damping material exhibits a damping coefficient higher than the damping coefficient of the material adjacent the isolation aperture. Also preferably, the damping material is constructed from layered dissimilar materials. For example, elastomeric materials have been found useful as part of the dissimilar materials used to form the damping materials. The head suspension formation process **200** concludes at end process step **218**.

Accordingly, embodiments of the present invention are generally directed to a method (such as **200**, as described hereinabove), an apparatus (such as **120**), and a combination (such as **100**) which includes a rotating disc (such as **110**) in a data exchange relationship with a read/write head (such as **114**) supported by a head suspension (such as **120**) apparatus as formed by the method.

The method preferably includes the steps of; forming a mounting region (such as **148**) adjacent a bend region (such as **142**) while a load beam region (such as **150**) is formed adjacent the bend region (such as by process step **204**); removing

material (such as by process steps 206 and 208) from the bend region forms an aperture (such as 164), a strut (such as 144), an isolation aperture (such as 146) and a damping material support structure (such as 136). The method preferably continues with the step of affixing a damping material to the strut and the damping material support structure (such as by process step 216).

The apparatus includes the bend region preferably adjacent both the mounting region and the load beam region. The load beam region includes a rigid portion (such as 154), which preferably supports a flexure (such as 160). The flexure provides means for attaching the read/write head to the head suspension.

10 The apparatus further preferably includes the damping material attached to both the strut and the damping material support structure.

It will be clear that the present invention is well adapted to attain the ends and advantages mentioned as well as those inherent therein. While presently preferred embodiments have been described for purposes of this disclosure,

15 numerous changes may be made which will readily suggest themselves to those skilled in the art and which are encompassed in the appended claims.